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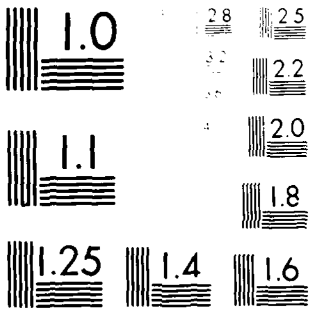

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GENERIC TEST BED (GTB) AIRCRAFT

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December 1981

Final Report for Period 1 May 1980 - 1 October 1981

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DIRECTORATE OF EQUIPMENT ENGINEERING
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The Night Attack Workload Steering Group (NAWSG) was requested by HQ AFSC/SD to investigate the need for a Generic Test Bed aircraft and to identify potential candidate aircraft. The team learned a need existed for an aircraft that could perform near the night attack envelope. The aircraft is needed to test, under realistic conditions, both the avionics and their effect on pilot crew workload. The team also identified several potential candidate aircraft that had sufficient cockpit space, volume, cooling and power to permit it to support this mission.

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PREFACE

The purpose of this report is to document the effort which was undertaken by the operational Experience and Flight Test Subgroup as part of the Night Attack Workload Steering Group. The report discusses the need for a Generic Test Bed aircraft, various design alternatives, candidate aircraft selection process, management organizations, and general results and recommendations.

The authors wish to express their appreciation to the USAF Reserve, AFWAL/AA/FI/TE, and the 4950th Test Wing who made available personnel to assist in the preparation of this document.

A special acknowledgement is made to Ms. Dawn L. Watson whose many hours of typing and editing was of great benefit to the authors.

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SUMMARY

1. INTRODUCTION

This summary presents the major findings and recommendations contained in this report.

Issues with regard to the Night Attack/Adverse Weather (NA/AW) avionics acquisition process were identified and are briefly noted below. It is believed that employment of a Generic Test Bed (GTB) aircraft can enhance the resolution of these issues.

This report is a response to the basic questions regarding the employment of and the benefits associated with the use of a GTB aircraft. It deals with the selection of possible design alternatives and candidate aircraft and is intended to stimulate a positive response to the concept of a GTB aircraft.

The report is a combined effort of engineers assigned to the Operational Experience and Flight Test Subgroup of the Night Attack Workload Steering Group, Flight Dynamics Laboratory and the 4950th Test Wing. In addition, much information was obtained from the results of a special study conducted in 1977 by AFWAL and ASD/XR to develop a General Avionics Test Bed (GATB).

2. DISCUSSION

There is a need for coordination of NA/AW avionics development to integrate equipment into new weapon systems. Flight testing of avionics on an integrated basis is needed early enough to provide a beneficial influence on avionics development. Integrated avionics flight testing is presently inadequate and contains several undesirable conditions:

a. A lack of test effort continuity and a comprehensive historical data base

b. Inefficient use of test aircraft due to considerable modification/demodification activity and dedication of aircraft to a single or limited project.

This inadequacy carries over into the acquisition of NA/AW avionic systems. There is a lack of standardization and commonality which leads to a proliferation of separately acquired equipment. This inadequate commonality results in the need to supply and logistically support an excessive amount of diverse equipment. Finally, this current approach does not permit acquisition of an avionic suite optimally designed to meet NA/AW mission requirements.

3. ACQUISITION APPLICATIONS FOR GTB

The GTB should be used primarily to test integrated advanced development avionics for transition to engineering development and ultimate employment in new NA/AW weapon systems. The testing will be accomplished in a realistic environment to determine the need for further design or development efforts. In the process, a data bank pertaining to equipment tested will be accumulated to aid in planning and decision making relative to avionics systems. The employment of the GTB would provide for an orderly transition of NA/AW avionics development.

There are several benefits which can be associated with the proposed use of the GTB. These include the opportunity to enhance the mission effectiveness of operational aircraft in the NA/AW environment, and the development of a comprehensive historic data base to assist in planning for future weapon systems.

4. SUMMARY

The employment of the GTB will not replace nor is it expected to replace all existing testing capabilities. The GTB will not solve all our avionics acquisition problems. It will provide a unique opportunity to control and coordinate the development and acquisition of future integrated avionics for the NA/AW mission. It will also provide a highly sophisticated airborne laboratory which could be used for a multitude of joint Air Force/Navy programs.

The GTB should be managed from AFWAL, Wright-Patterson AFB with organic support provided for aircraft operation, maintenance and modification by the 4950th Test Wing. Several aircraft, which were evaluated against specific program requirements, have been identified as acceptable GTB candidates. Of this list of candidate aircraft, the Navy's S-3A Viking was identified as our primary choice.

SECTION 1

INTRODUCTION

1. BACKGROUND

Headquarters Systems Command in a message to Tactical Air Command and the Aeronautical Systems Division, subject Night Attack Capability, requested a plan be developed to select a test bed aircraft considering all the options/costs/limitations and requirements. The Operational Experience and Flight Test Subgroup of the Night Attack Workload Steering Group (NAWSG) was tasked to develop this plan for a "Generic" Test Bed (GTB). The charter as established by this group was to identify, via a structured selection plan, an aircraft or several different types of aircraft to fulfill the role of a GTB. The purpose of this aircraft will be to flight test prototype and developmental Night Attack/Adverse Weather (NA/AW) avionics, assess pilot work load, and enhance data derived from ground based simulation and avionic development programs. All flight testing will be conducted under realistic flight conditions. This would include low altitude, high speed penetration, target acquisition, threat avoidance, weapon launch, and egress from target.

2. MISSION DEFINITION

The original concept envisioned for the Generic Test Bed was an airborne laboratory for flight testing avionic components and systems. The Operational Experience and Flight Test Subgroup believe the aircraft actually has a dual role. In addition to the flight testing of avionic systems, the aircraft should be used to study the pilot/avionic interface during a night attack/adverse weather mission and the changes to pilot work load as influenced by different avionic suites. We believe our current flight test philosophy does not give us this capability. Current methods of flight testing avionics provides early test results which may not be valid across the range of all aircraft to use the new system, and this may not be apparent until the OT&E stage. The options then become either a very costly redesign of the new system, a degraded operational capability, or a decision not to use it at all. An example of this could be the F-4E/ARN-101 digital avionics aircraft. The following excerpt was taken from the Pave Tack Night Attack System/F-4 IOT&E Final Report, "TAC Project 76C-020T, November 1979."

"Overall, the cockpit configuration of the test aircraft was deficient. The arrangement of control panels, control functions, the Pave Tack control handle, and the Virtual Image Display Unit (VIDU) controls were not optimized and did not lend themselves to effective or efficient system operation by the Weapon System Operator (WSO). Operation of some of the controls caused interference with the control stick, cross handed operations, and inadvertent activation of other controls."

The aircraft required to meet this mission must be able to approach the performance characteristics of the aircraft the particular avionics suite is being designed for. The aircraft must be able to investigate the work load of either a single or dual crew membered aircraft. Ideally, this would be under the surveillance of a third safety pilot. The aircraft would need to have the capability to simulate weapon launch, sufficient internal volume for avionics under test, power distribution, environmental control, and flight test instrumentation. Finally, the aircraft cockpit must be easily modified to duplicate any one of several NA/AW fleet aircraft.

SECTION II

DISCUSSION

The A-10, F-15, and F-16 aircraft can reasonably be expected to remain in service past the year 2000. These aircraft will have utility for such a long period of time only because of rejuvenation through a series of avionics retrofit programs. These retrofits will be done either to save operating expenses, retain a mission capability at an acceptable level in response to changing conditions, gain an operational advantage made possible by a technological opportunity, or acquire a new mission capability, such as adapting the above aircraft to the NA/AW mission role.

There is a realization that retrofits require long term planning and not ad hoc efforts in response to unique and immediate challenges. Furthermore, for such retrofits, there is a stated need for extensive avionics system testing rather than only avionics subsystem or avionics component testing. Coordinated avionics systems planning is needed rather than piecemeal planning. Too often avionic system planning is undertaken only after weapon system planning or development is underway.

New aircraft developments with significant NA/AW avionics requirements represent the longer range interests of the Air Force and will provide opportunities to demonstrate the multi-role capability of the Generic Test Bed. An increasingly important factor is the use of digital-multiplex subsystems in new aircraft systems, such as the MIL-STD-1553B mux bus. This concept provides the capablity to process information between diverse avionics elements which are essential to the aircraft mission. Thus, a critical aspect of developing these weapon systems is to obtain effective evaluations of the interoperability of the avionics subsystems.

1. VALUE OF TESTING

There is a growing realization that testing is not something undertaken long after planning is finished, but rather, testing is something done to lay a foundation for good planning. There clearly is a need for avionics system testing as a prelude to the planning of avionics systems for application to weapon systems.

Development planning is forward looking and should be concerned with using laboratory and flight test data for decisions pertaining to the future. There is a need for a program which, as a part of development planning, provides the means to produce credible data for decisions on future NA/AW avionics system programs. Such a program would be supportive of the entire decision making process.

Currently there is inadequate long range NA/AW avionic systems planning in that specific needs to satisfy future mission requirements have not been identified to guide the initiation of appropriate R&D programs. There is no mechanism to enforce and control an orderly progression of effort from exploratory development to production.

2. TEST AND EVALUATION

Flight testing of avionics systems is an expensive and time-consuming task. A significant part of the expense can be attributed to:

a. The cost of test aircraft modifications to accept systems to be tested.

b. Modification of systems under test to be compatible with the test aircraft.

c. Diverse test activities and lack of test continuity, leading to separate requirements for test instrumentation and hardware.

d. Nonavailability of test aircraft during modification and demodification.

Avionics flight testing has historically been accomplished on a step-by-step basis. That is, the equipment is not generally tested as part of an integrated system. This has resulted in subsequent problems related to interoperability when integrated testing is not included in the testing process.

Any program which would increase the availability of the test fleet would make additional testing possible. Standardization of interfaces would also minimize test item changes and to a limited extent, permit simultaneous use of the same test aircraft for more than one system flight test.

3. AVIONIC SYSTEM TESTING

Avionic system testing begins with breadboard designs and progresses through to flight tests of production equipment in the actual aircraft for which it is intended. The four phases of avionic system testing can be described as follows:

a. Breadboard Packages This is to verify the concept only. Such concerns as size, weight, power, and cooling are not a major factor at this point. Circuitry is often hand wired and sometimes even designed by trial and error. The intent is to verify that the concept is viable and does work. The type of aircraft on which it is tested is not of primary concern to the avionics engineer.

b. Developmental Testing and Evaluation (DT&E) The avionic system has progressed to where a prototype of the final hardware is being tested. Packaging, volume, power, cooling, vibration, and g tolerance are now a concern. Design changes are made where necessary, although it is more difficult and expensive than in the breadboard stage.

c. Operational Testing and Evaluation (OT&E) - The design is nearly finalized and the prototype is certified by DT&E as representative of a production system. Testing is user oriented to determine operational effectiveness and suitability.

d. Follow-on Operational Testing and Evaluation (FOT&E) - A production avionics system is installed and tested in each aircraft for which its use is intended. Its purpose is to refine initial estimates of operational effectiveness and suitability, to identify operational deficiencies, to evaluate system changes, or to re-evaluate the system against changing operational needs. Changes to items in the field or in production are more costly than preproduction changes.

4. SYSTEM FLEXIBILITY

Avionic system design is most flexible in the conceptual, or breadboard, stage of development. Component designs or subsystem functions can readily be altered to correct for limitations discovered during flight testing, due to advances in the state-of-the-art or changes in mission requirement. As the system design matures and hardens, the ability to incorporate design changes decreases.

a. Ability to Gather Work Load Data

The pilot work load is impacted by the avionics suite provided the pilot. Just as with the design of the electrical circuitry itself, the capability to modify the design, based on the results of pilot work load studies, is greatest while the avionic package is in the breadboard stage. Unfortunately, from the designer's standpoint, the best measurements of the impact of avionics on pilot work load are obtained not when the avionics is in the breadboard stage but later on in the development cycle when changes are extremely difficult to incorporate.

5. STATEMENT OF NEED

For reasons already discussed, studies conducted early in the development cycle of avionic systems do not permit a realistic assessment of the impact avionics has on pilot work load. Delaying these studies until the avionic systems reach the stage of being point designs, permits accurate work load assessment, but restricts the capability to modify these designs. A broad based pilot work load evaluation at the earliest possible point is of particular concern in the NA/AW mission, because it is one of the most demanding tasks for both the pilot and the aircraft. We believe there is a point in the development cycle of avionic systems where the design is still flexible yet advanced enough to permit, if installed in a suitable flight test vehicle, an accurate evaluation of pilot work load. That point occurs between the breadboard design stage and the DT&E state. (Figure 1)

a. Breadboard Stage Flight Testing

Flight testing of avionic breadboard designs generally requires dedicated test bed aircraft. The Air Force currently has available the resources necessary to flight test breadboard avionic systems/components. Air Force Systems Command has three flight test centers that manage a vast assortment of these dedicated aircraft uniquely suited for this

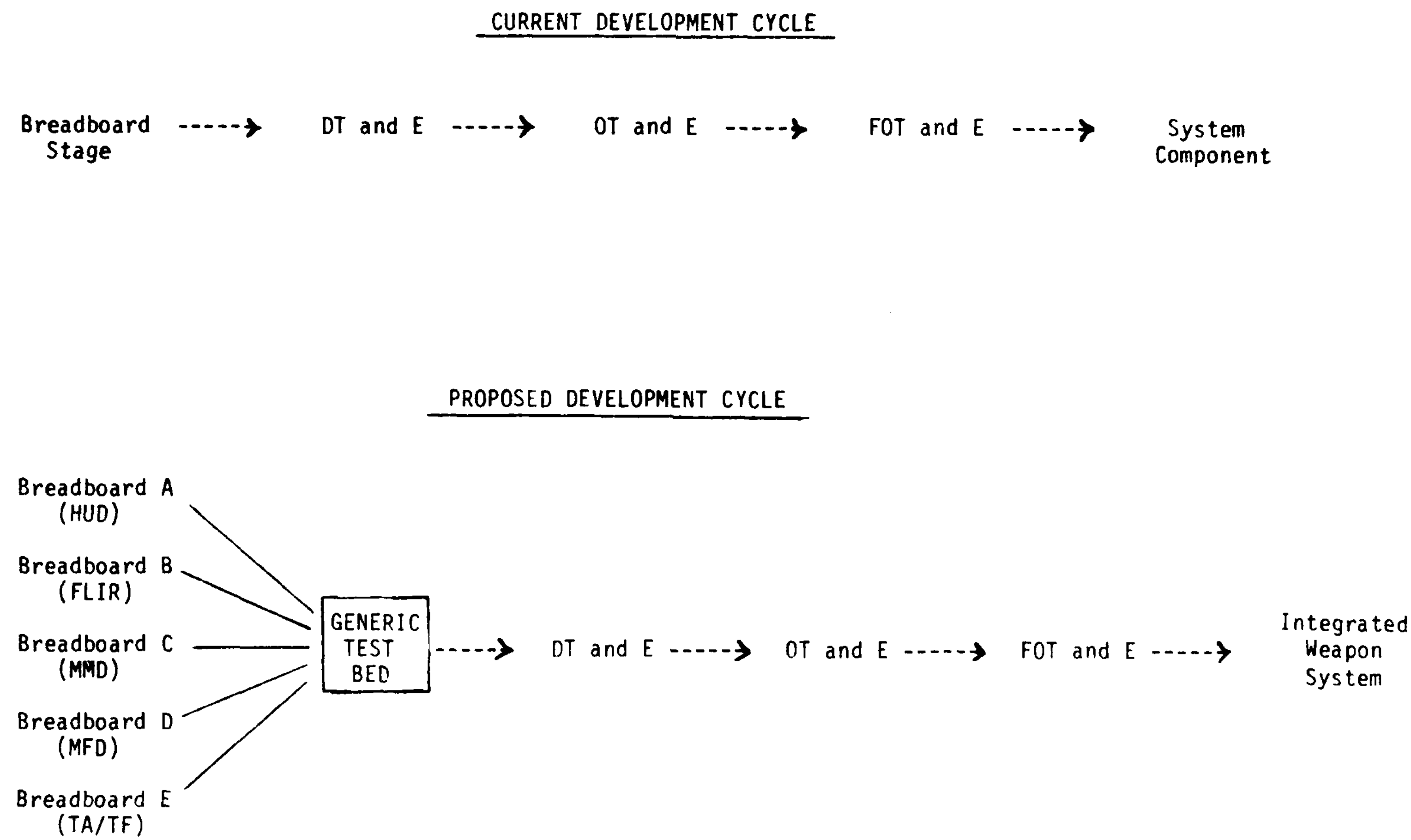


FIGURE 1. GTB INTERACTION

mission. Most existing flight test aircraft have the volume, power, and cooling capability to support large instrumentation packages. They also have on-board data reduction capabilities, relatively unrestrictive packaging constraints of the test systems/components, and in-flight troubleshooting capabilities.

The 4950th Test Wing at Wright-Patterson AFB, Ohio operates such aircraft as C-141s, C-135s, C-130s, and T-39s. In addition, the Wing's Modification Center has the capability to design, fabricate special equipment, and modify flight test aircraft to meet the needs of the technical community. The 3246th Test Wing at Eglin AFB, Florida operates such aircraft as F-15s, F-111s, A-7s, F-4s, and others. The Air Force Flight Test Center at Edwards AFB, California operates B-52s, C-135s, F-4s, etc. In addition to the three test centers, the AFSC Laboratories manage several bailed and Government Furnished Property (GFP) aircraft as specially modified flight test vehicles such as the NC-131H Total In-Flight Simulator operated and maintained by the CALSPAN Corp and managed by the Flight Dynamics Laboratory. In summary, to flight test breadboard avionics, current Air Force resources are adequate to meet the needs of the NA/AW community.

b. DT&E Flight Testing

Flight testing of avionic point designs is also currently available within the Air Force. Such AFSC organizations as the 3246th Test Wing at Eglin AFB have the resources to modify and operate aircraft for the purpose of flight testing avionic systems in operational scenarios. In addition, several contractors can provide the same capability (i.e., McDonnell Douglas Strike Eagle Program, Fairchild two seat A-10, LTV A-7K).

c. Proposed Generic Test Bed Stage

As previously stated, we believe a void exists in the testing capability between the breadboard stage and follow-on stages. This void can best be filled by a "Generic Test Bed" (GTB) aircraft with the capability to test breadboard and developmental avionics in realistic mission scenarios, while simulating the flying qualities, handling characteristics, and cockpit environment of each of the aircraft that will eventually use the new systems. This approach will insure the validity of test results to all aircraft, while allowing changes to be made early in the program.

The GTB aircraft could be used to support several basic areas of NA/AW avionics development. It could be used for the development of new avionics technology, fleet avionics updates to add capabilities, counter new threats, take advantage of advanced technology capabilities, or undertake new mission roles other than the NA/AW mission and the development of avionics suites for new weapon systems.

With respect to aircraft, the GTB program could involve either similar or specific test bed approaches. The similar approach would reflect an intent to use aircraft representative of the NA/AW fleet in order to obtain avionics test data for overall fleet applications. Using the specific test bed approach, it would be necessary to employ test vehicles corresponding to each of the operational NA/AW aircraft. The similar approach requires an aircraft which is capable of flying a NA/AW mission profile and has sufficient on-board capabilities to meet the needs of an avionics test bed. The specific approach requires an aircraft which can duplicate as much as possible the actual configuration and handling qualities of all candidate NA/AW aircraft. This approach also permits the gathering of valuable pilot work load data.

SECTION III

POTENTIAL BENEFITS ASSOCIATED WITH THE GTB

A number of benefits are possible through employment of a GTB program. These essentially have to do with the versatility of the generic concept in accepting new avionics components/suites readily, the existence of a dedicated test activity, including appropriate facilities, and a suitable management structure to obtain and apply flight test data effectively.

Testing would be more efficient using the GTB. Functioning with a properly equipped and managed ground based simulator, the test flights should be more productive with a continuing and dedicated test activity, and there would be a reduced need to acquire operational aircraft for flight testing. The integration of interacting components through standard hardware, and software interfaces would be simplified. Thus, the GTB could be more rapidly configured to perform a specific test project or possibly accomplish different projects simultaneously. Modification and demodification times would be reduced allowing more productive flight test hours.

Testing would also be more effective. Because of the factors listed above, the GTB could be readily configured and thus be more responsive to test needs. Because of the continuity of test operations, the test data could be more effectively processed and analyzed. The test data analysis would take place in an environment of corporate history with respect to previous, possibly related efforts. Thus, effective comparisons could be made.

The GTB would also provide a greater opportunity to test the interoperability of NA/AW avionics, providing an opportunity to insure the system elements play together properly. Another benefit closely associated with avionic interoperability is the ability to assess the man-machine interface. Since our current efforts are normally piecemeal, the first full systems integration in the operational aircraft occasionally led to unanticipated difficulties.

The GTB provides the opportunity to evaluate the capabilities of avionic equipment earlier in the development cycle. This would reduce development risks by providing data sufficiently early to avoid costly engineering changes.

SECTION IV

USE OF SIMULATORS FOR NA/AW AVIONICS EVALUATION

Consideration was given early in the study of a GTB aircraft as to the feasibility of utilizing a ground based simulator in lieu of an actual aircraft. Quite extensive discussions were held by the members of the NAWSG and a consensus was reached by this group. The nearly unanimous agreement was that simulators will play an extremely important role in the development of avionic suites and that much can be learned about how these avionic suites affect pilot work load. But, simulators cannot provide realistic cues to the pilot which duplicate the NA/AW conditions he and his equipment will be subjected to. Especially, the simulator cannot provide the same stress levels (also called pilot gain or pucker factor) which the pilot would be subject to in an actual flight environment. The ground based simulator, therefore, can only simulate the real world and can approach, but not reach, reality. The final step in confident testing is flight testing in the actual environment. The simulator provides the development facility for integration, system verification, preflight testing, and pilot procedural training. The simulator makes its greatest contribution by increasing the probability of successful flight tests, not by eliminating the need for flight tests. The following concept of operation expands upon this.

1. CONCEPT OF OPERATION

Prior to flying the GTB, it is proposed that a Human Factors Engineering (HFE) Simulator, uniquely configured to complement and support the flight test aircraft, be employed to initally evaluate the proposed avionics suite. The HFE simulator would permit crew station and human factors engineers and the users to design, modify, and test various design options prior to actual airborne tests. These ground-based tests could start with cockpit studies and progress to man-in-the-loop real time simulation. This will pave the way for flight testing by eliminating some design options, assist in predicting results, optimizing the use of the GTB, and in general, complementing the data obtained in flight test.

The ground based simulator would also contain a hot bench with core elements and operational software which are functionally identical to those in the GTB. The flight tests would be simulated before and after the flight. The hot bench will provide the tools to perform avionics preflight tests and postflight analysis.

SECTION V

NA/AW MISSION SCENARIO

The NA/AW aircraft will likely be employed at low altitudes (below 500 feet AGL) and maximum high speeds (near supersonic range - Mach 0.7 to 0.95). This will permit the aircraft to hide from threats, decrease exposure time to enemy fire on certain targets depending on the aircrafts' capabilities and, in general, improve system survivability. This is a very taxing environment for the crew because the aircraft will likely be flying at low altitude for most, if not all, of the mission. The crew must remain free of the threats, locate the target, attack, and destroy it and return home. The NA/AW mission places limitations on the use of daytime combat techniques. The pilot will be constrained in such areas as maneuvering and maintaining situation awareness.

The current USAF fleet has some aircraft capable of limited operation at night, low altitude, and in weather. These aircraft are dependent upon radar as the primary sensor. Because radar has limitations, such as jamming susceptability and weather interference, a number of other sensors are under study for use in the NA/AW environment.

The GTB aircraft will assist in the development of these and future sensors. The aircraft will fly mission scenarios that duplicate the NA/AW profile flown by combat aircraft to test the selected equipment suite and cockpit arrangement decided upon after extensive ground simulation studies. In the case of the GTB, certain aspects of the mission would be simulated. Night can be duplicated using a blue/amber or comparable system in the cockpit and weapon carriage/release could also be simulated electronically. Most test flights would, for safety of flight reasons, be flown day VFR.

SECTION VI

OPTIONS

Basing our selection on the above assumption that the GTB should not be solely an avionics test bed but also a pilot work load evaluation platform, the following selection process was used to identify the options available to us.

The selection process encompassed several steps.

a. Identify and evaluate test bed design alternatives.

b. Identify and evaluate all possible candidate aircraft.

c. Select one or more feasible design alternatives and applicable candidate aircraft.

1. OPTIONS CONSIDERED

Several design alternatives were identified and evaluated. They are:

a. Modular Panels

b. Modular Cockpits

c. Multiple Aircraft

d. Terminal Configured Vehicle (TCV) Concept

e. Total in Flight Simulator (TIFS) Concept

f. Generic Cockpit

2. FACTORS CONSIDERED - DESIGN ALTERNATIVES

The factors considered during the evaluation of the design alternatives are shown below in a descending order of importance. This order of importance was based on a qualitative assessment by the authors.

a. Extent of the modification - difficulty and cost

b. Validity of data obtainable during flight test

c. Flexibility - minimal change-over times, adaptable to new concepts/configurations, growth potential

3. FACTORS CONSIDERED - CANDIDATE AIRCRAFT

Forty-two candidate aircraft (US military, commercial and business) were considered (Table 1). Foreign aircraft, including those from NATO countries, were not considered because of supportability problems with one-of-a-kind aircraft.

The factors considered during the evaluation of candidate aircraft are listed below in a descending order of importance.

a. Adaptability to the modification - can the aircraft feasibly be modified to a particular configuration (volume, power, cooling, etc)

b. Validity of data obtainable during flight test - can aircraft fly NA/AW mission profiles.

c. Availability of aircraft

d. Flexibility - growth potential, onboard instrumentation/telemetry feasible, adaptable to new concepts

e. Operating/maintenance costs

f. Current onboard systems applicable to NA/AW missions

(1) Standard 1553 Bus

(2) INS (Inertial Navigation System)

(3) FLIR (Forward Looking Infra-Red)

(4) Ground Target Indicator

(5) Laser Designator

(6) MFD (Multi-Functional Display)

(7) MMD (Moving Map Display)

(8) Radar Altimeter

(9) TA/TF (Terrain Avoidance/Terrain Following)

(10) Wide FOV (Field of View) Programmable HUD (Heads Up Display)

(11) WDS (Weapon Delivery System)

(12) Safety Pilot

The factor addressing current aircraft systems was not weighted heavily because the GTB aircraft, restricted to day VFR missions in local test ranges, will probably have virtually all systems removed. This will permit maximum flexibility as a GTB.

TABLE 1. CANDIDATE AIRCRAFT

A-6E	F-15B
A-7K	F-16B
AV-8A	F-18
A-10B	F-111 D/F
A-37	FIGHTER TIFS
BOEING 727	FALCON SERIES 10/20
BOEING 737	GULFSTREAM II/III
C-9	JETSTAR II
C-12	KC-135
C-130E	LEARJET SERIES 35A/36A
C-131E	NT-33
C-140	S-3A
CESSNA CITATION I/II	T-37
CALSPAN LEARJET	T-38
DIAMOND I	T-39
F-4E/RF-4C	T-43
F-5	TCV (TERMINAL CONF. VEHICLE)
F-14	TIFS (TOTAL IN-FLT. SIM.)

SECTION VII

INVESTIGATION

Following is a synopsis of our preliminary evaluation of the design alternatives and candidate aircraft. Included in the synopsis is a brief description of the modification and its advantages and disadvantages. Table 2 provides a tabular evaluation of all alternatives. Instrumentation will not be addressed since an instrumentation package (on-board and telemetry) and a pilot work load data collection system would be common to all configurations. For flight safety considerations, a safety pilot is also mandatory.

1. MODULAR PANELS

This alternative utilizes as the test station either the front seat of a tandem fighter/trainer or the right seat of a side-by-side configured cockpit. The cockpit physical configuration of an NA/AW aircraft would be simulated in the GTB. The side consoles, forward instrument panel and center pedestal, stick and throttle controls would be duplicated as much as possible with interchangeable components. This will permit as much reconfiguration of the GTB as possible into any one of several cockpits of actual candidate NA/AW aircraft.

a. Some of the advantages of this alternative include the following:

- The aircraft can be configured to represent existing cockpits
- The aircraft can be configured to represent future advanced cockpit designs
- This would permit full utilization of limited (i.e., one aircraft probably) resources
- Although direct modification costs cannot be obtained, the modification is within acceptable levels of difficulty, risk and cost
- The GTB could provide realistic visual and motion cues to the test subject by flying NA/AW mission profiles
- Panels can be built up independent of aircraft, allowing the next test to be in preparation while one is in flight test.

b. Some of the disadvantages of this alternative include the following:

- Because the GTB with modular panels would be essentially one aircraft simulating many, a variable stability flight control system may be needed to duplicate specific NA/AW mission aircraft flight

TABLE 2. DESIGN ALTERNATIVES SYNOPSIS

FACTORS / ALTERNATIVES	COMPLEXITY/COST OF MODIFICATION	MEETS PROGRAM OBJECTIVES	FLEXIBILITY/ ADAPTABILITY	GROWTH POTENTIAL	SUPPORTABILITY OF GENERIC TEST BED A/C	SAFTEY PILOT	OTHER
MODULAR PANELS	As compared to the other alternatives, the complexity level is medium.	Meets objective of avionic test bed. Permits realistic pilot work load study.	Readily flexible and adoptable to meet current and future cockpit designs.	Only limited by size of parent aircraft TCV and TIFS has greatest amount of growth potential	Organic and/or contractor support viable.	YES	AFSC capable of performing modifications. Viable alternative.
MODULAR COCKPITS	Complexity level is extremely high.	Meets objective of avionic test bed. Permit realistic pilot work load study.	Readily flexible and adoptable to meet current and future cockpit design.		Complexity level dictates contractor support.		Complexity of modifications probably dictates contractor effort.
MULTIPLE AIRCRAFT	Complexity level is low.	Meets objective of avionics test bed. Permits realistic pilot work load study.	Readily flexible to meet current cockpit designs.		Organic and/or contractor support viable.		AFSC capable of performing modifications. Viable alternative.
TCV	Complexity level is extremely high.	Meets objective of avionics test bed.	Readily flexible and adoptable to meet current and new cockpit designs.		Organic and/or contractor support viable.		Complexity of modifications probably dictates contractor effort.
TIFS	Complexity level is extremely high.	Meets objective of avionics test bed.	Readily flexible and adoptable to meet current and new cockpit designs.		Complexity level dictates contractor support.		Complexity of modifications probably dictates contractor effort.
GENERIC COCKPITS	Complexity level is low.	Meets objective of avionics test bed. Permits semi-realistic pilot work load study.	Readily flexible and adoptable to meet current and future cockpit designs.		Organic and/or contractor support viable.		AFSC capable of performing modifications. Viable alternative.

characteristics. A variable stability flight control system is listed as a disadvantage primarily due to cost and complexity although several test aircraft have this system installed and have used its capabilities successfully for many years. Program costs could double with the addition of a variable stability flight control system.

- This alternative would require lengthy turnaround times between reconfigurations of the cockpit. Potential for quicker turnaround is possible if equipment and instruments can be set up to plug into existing wiring through junction boxes, or if all instruments are interfaced to CPU by means of a 1553B MUX bus.

2. MODULAR COCKPITS

This alternative utilizes as the test station a removable forward cockpit of a tandem fighter or trainer aircraft. The forward cockpit would be a duplicate of a particular NA/AW candidate aircraft. The removable cockpit would permit more precise simulation of test cockpit instrumentation and controls.

a. Some of the advantages of this alternative include the following:

- The aircraft can be nfigured to represent existing NA/AW mission aircraft cockpits

- The aircraft can be configured to represent future advanced cockpit designs

- This modification alternative wou' ' permit full utilization of limited (i.e., one aircraft probably) resour.es

- The GTB could provide realistic ques to the test subject by flying NA/AW mission profiles

b. Some of the disadvantages of this alternative include the following:

- May require a variable stability flight control system.

- This alternative would require extremely extensive turnaround times between reconfigurations of the cockpit because of flight control, life support, etc. interfaces

- According to information obtained from the AFWAL/TE TIFS program, the costs associated with this alternative would be prohibitive

- The modification would entail unacceptable levels of difficulty and program risk

- Extensive design and structural changes would have to be made

3. MULTIPLE AIRCRAFT

This alternative would require the use of several different aircraft. Each aircraft selected would be from existing inventory candidates for the NA/AW mission (i.e., F-15, F-16, F-4, F-111). Each aircraft would require modifications to provide full aircraft flight test instrumentation, pilot work load studies, test bed power/cooling, safety pilot, and test pilot stations. Test cockpits would be configured for that particular aircraft. New avionics would be appropriately fitted to that aircraft.

a. Some of the advantages of this alternative include the following:

- o Does not require a variable stability flight control system
- o Configured to represent actual NA/AW mission aircraft
- o Capability to provide realistic cues to the test pilots
- o The required modifications would be minor

b. Some of the disadvantages of this alternative include the following:

- o Would require the operation and maintenance of several different aircraft
- o Difficult to fully utilize all aircraft
- o Limited flexibility to investigate new concepts in cockpits and aircraft
- o Would require several Air Force resources to be dedicated to a flight test mission which may not be able to fully utilize them
- o Each aircraft would require a complete Class II modification to support the flight testing.

4. TCV CONCEPT

This alternative requires the addition of a second test cockpit in the cargo/passenger section of a larger parent aircraft. This test cockpit would simulate potential candidate NA/AW aircraft. This alternative is derived from the "Terminal Configured Vehicle" (TCV) which is managed and operated by NASA at Langley Research Center (Figure 2). The TCV program is a research activity focused on the development of advanced operating systems technology necessary for conventional transport aircraft to operate routinely in reduced weather minima in a future high-density terminal area. The broad objectives are to perform research to develop and evaluate new concepts of airborne systems and operational flight procedures in advanced air transportation system environments. As an aid in meeting these objectives, a Boeing 737-100 series airplane,

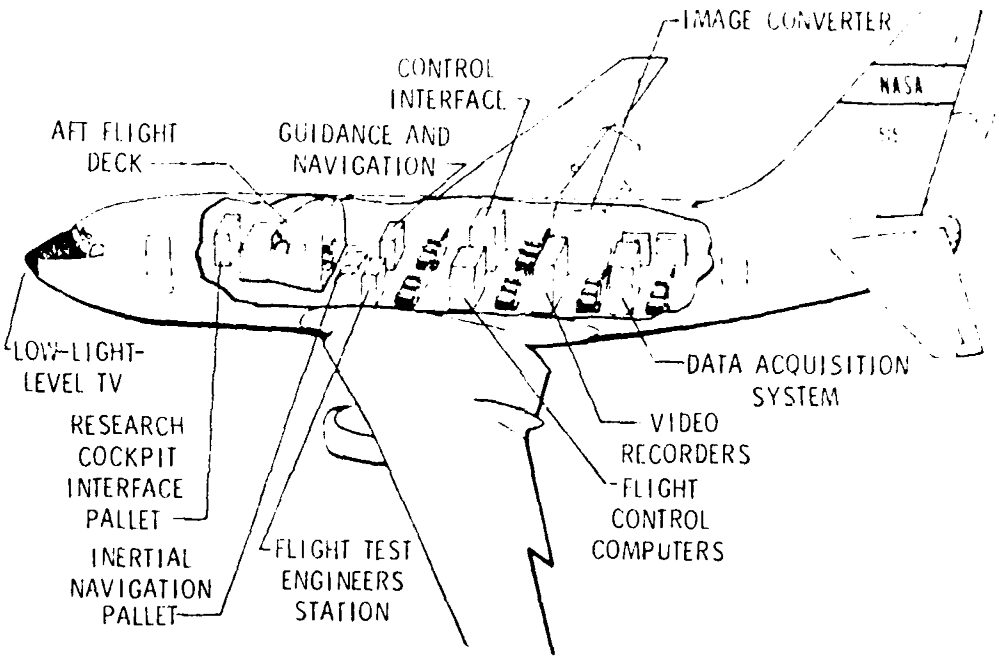


FIGURE 2. TERMINAL CONFIGURED VEHICLE

was obtained and a second flight deck and an array of computers and monitors were installed in the passenger compartment. The airplane can, of course, be flown from the forward flight deck with conventional controls or from the aft flight deck using a fly-by-wire system. The generic test bed program would incorporate basically the same type of capability as the TCV.

a. Some of the advantages of this alternative include the following:

- The cockpit design is flexible and adaptable to future cockpit configurations.

- The parent aircraft, because of its size, should have sufficient power, cooling and volume capacities to permit extensive flight test instrumentation, in-flight troubleshooting, on-board data reduction and relatively unrestrictive packaging constraints

- This built-in flexibility would permit full utilization of limited (i.e., one aircraft) resources

b. Some of the disadvantages of this alternative include the following:

- A variable stability flight control system would be required

- The modifications required would be quite extensive

- Aircraft would not be able to fly nor realistically simulate the NA/AW mission because of its low performance

- The aft cockpit would not give visual and other cues to the pilot. An aft cockpit would be useful as an avionic test bed but any results from pilot workload studies would be suspect. Visual cues are considered important because NA/AW may very well be haze, fog, etc.

5. TIFS CONCEPT

This alternative requires the addition of test cockpits to the nose section of a larger parent aircraft. This additional test cockpit section would simulate potential candidate NA/AW aircraft. This concept is based on the "Total In-Flight Simulator" (TIFS) which is managed by the Flight Dynamics Laboratory and operated by the CALSPAN Corp, Buffalo (Figure 3).

a. The advantages associated with this alternative are about the same as those associated with the TCV alternative with the additional advantages of visual cues presented to the test pilot.

b. The disadvantages associated with this alternative are about the same as those associated with the TCV alternative. In addition, this concept requires the manufacture of several different cockpit sections

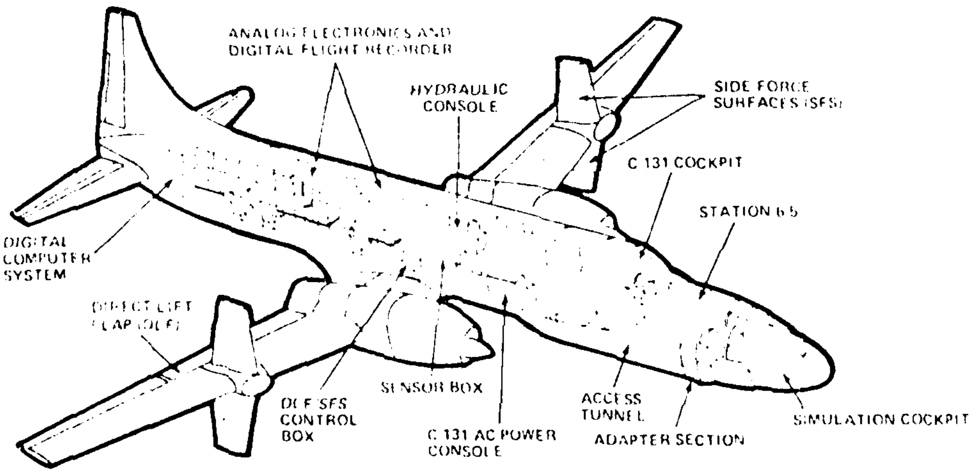


FIGURE 3. TOTAL IN-FLIGHT SIMULATOR

to fully evaluate the total range of present and future cockpit designs. The TIFS program has shown that to build several cockpits require prohibitive amounts of financial resources. As a result, only one TIFS section was built. This will probably be true of the GTB concept, resulting in a loss of flexibility.

c. A concern was raised during our visits to NASA, Langley and CALSPAN Corp dealing with the use of large test aircraft to obtain HFE data required by the NA/AW community to impact fighter aircraft designs. The concern was if the data obtained by a large aircraft in an essentially benign environment would be transferrable to a small fighter type aircraft in a low altitude, high speed environment. CALSPAN Corp and NASA, Langley believed the HFE data was not transferrable. Large aircraft just cannot generate the dynamics of a small aircraft nor fly the NA/AW mission profiles. Both believed the GTB must be capable of flying these profiles. Of course this is based on our initial assumption of what the mission of a GTB should be.

6. GENERIC COCKPIT

This alternative utilizes as the test station either the front seat of a tandem fighter/trainer or the right seat of a side-by-side configured cockpit. The test station would be used for testing of either single components or entire avionic suites without regard for duplicating specific aircraft cockpit configurations. The aircraft would be modified to provide test bed power, additional cooling, avionic test bed instrument racks, flight test instrumentation package, on-board data collection, telemetry and pilot work load studies instrumentation. The generic cockpit alternative would be used to provide a link between hardware/software technology, aircraft dynamics, and pilot information requirements. This concept is based on the NT33 managed by the Flight Dynamics Laboratory and operated by the CALSPAN Corp (Figure 4).

a. Some of the advantages of this alternative include the following:

- This concept would permit full utilization of limited resources

- There are several fighter aircraft now in the AFSC inventory which could possibly be used

- This type of modification has been performed numerous times in the past. Minimal cockpit modification required, quick turnaround between configurations possible

- The GTB could provide realistic cues to the test pilot.

b. Some of the disadvantages of this alternative include the following:

- A variable stability flight control system may be required

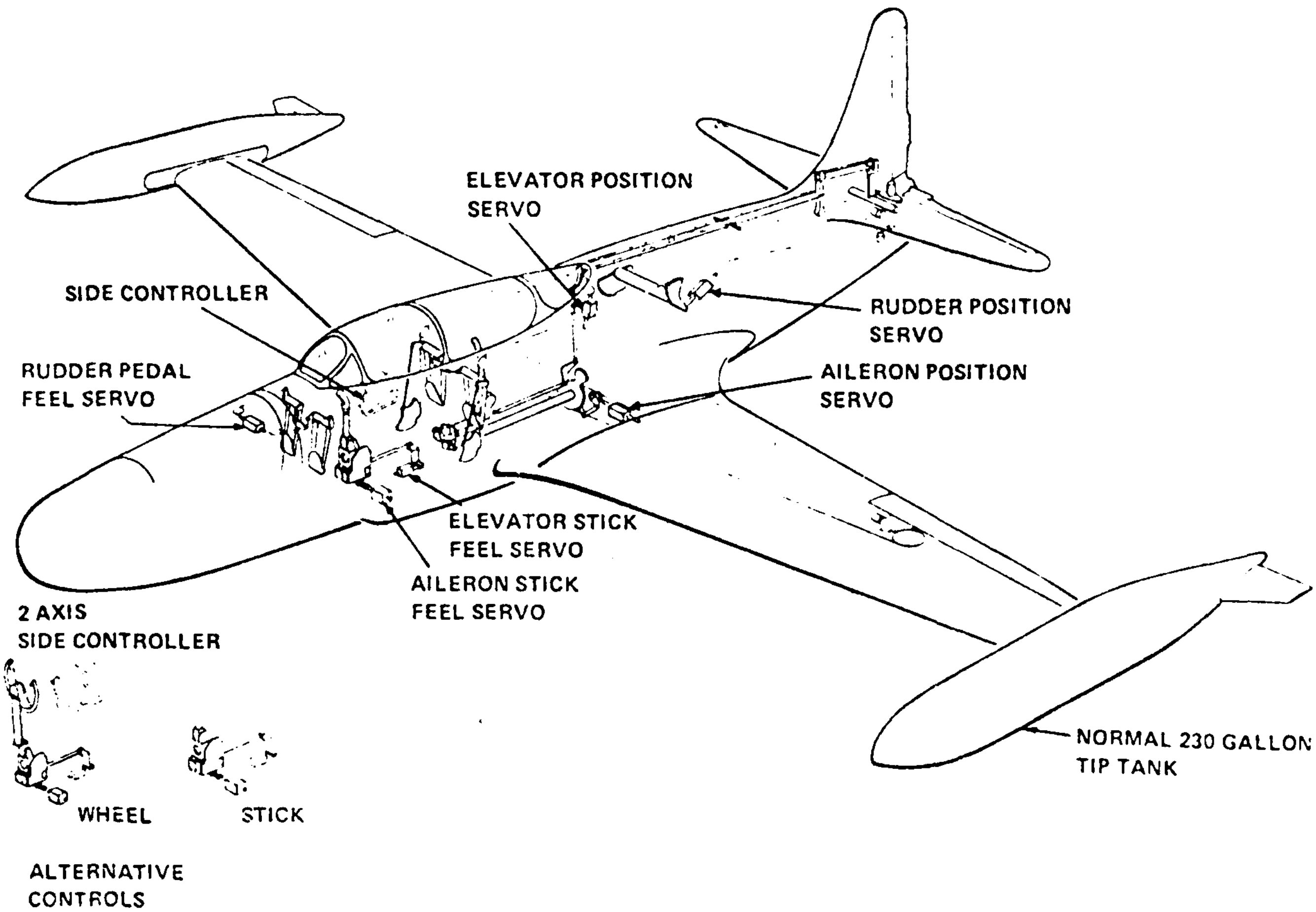


FIGURE 4. NT-33

- Pilot work load data obtained with this design would be somewhat suspect since the configuration is unique and the work load data obtained would be applicable to the configuration flown rather than for another specific aircraft.

7. VARIABLE STABILITY SYSTEM

Variable stability is a means by which the flight characteristics, handling qualities, and feel characteristics of a test vehicle can be altered in flight to make it duplicate the overall characteristics of another aircraft. The pilot's control inputs do not go directly to control surfaces, but to the variable stability flight control system (on which the desired characteristics are programmed), and then to the control surfaces. The Air Force's chief experience with variable stability aircraft has been with the NT-33A and NC-131H TIFS, both operated by the Flight Dynamics Laboratory. As examples of variable stability's versatility as a research tool, the NT-33A has simulated aircraft, such as the X-15, A-10, F-16, and F-18. The NC-131H has simulated the B-1, Concorde, C-5, and Space Shuttle.

a. Variable Stability Mechanization

There are two schemes in use to implement variable stability: response feedback and model following.

(1) Response Feedback

This is an older technology, and although more difficult to understand, it is often simpler to use. Essentially, Response Feedback takes the dynamics of the test vehicle and adds to or subtracts from them to produce the desired responses. The flight characteristics of the basic airframe are changed to a specific desired value. These characteristics are usually frequencies, dampings, and time constants. The Response Feedback is essentially a variable Stability Augmentation System (SAS), in which the gains are controllable to produce a range of desired dynamics.

(2) Model Following

This is a newer technique, very simple in concept, but more complex in mechanization. In Model Following, a complete model is programmed for each degree of freedom. The model in a Model Following system is the same as in a ground based simulator. Instead of producing motion in a moving base cockpit, the entire test vehicle is forced to match the response of the model to pilot inputs.

These two techniques are quite different, and each has its own advantages and disadvantages. With Response Feedback, since it is the dynamics that are being varied, the dynamics of the experimental configuration to be evaluated must be known. The test vehicle with the experimental configuration programmed must then be calibrated by trial and error,

usually requiring at least two flights. With Model Following, the dynamics of neither the test vehicle nor the experimental configuration need be known, but all the aerodynamic coefficients for that axis of the experimental configuration must. The model can be checked on the ground, and only a single verification flight is usually required.

b. Variable Stability and the GTB Aircraft

The GTB aircraft will be required to simulate the overall characteristics of all potential aircraft for the NA/AW role. Three major areas of concern must be considered: capabilities of each potential base vehicle, number of degrees of freedom, and type of variable stability mechanization. These three are not independent considerations: the first two deeply interrelated, and the third could be of significance.

(1) Capabilities

No two aircraft are alike. The A-7 does not fly like an A-10, which does not fly like an F-4, etc. This can be overcome by means of variable stability. But how much does it take to do it? There are nine potential base vehicles, and by using variable stability, any one should be able to simulate any other one. However, this may not actually be the case, due to other restrictions. It is desirable to have as simple a system as possible.

If candidate A requires a very sophisticated system to simulate B, C, D, and E, but candidate B can use a simpler system to duplicate A, C, D, and E, this would favor candidate B. Generally, the more sophisticated system will take longer to develop, will cost more, will require more maintenance, and possibly will fail more often. Other factors that may influence base vehicle selection are internal volume available, weight carrying ability, and electrical and hydraulic system adequacy.

(2) Number of Degrees of Freedom

All aircraft have six degrees of freedom. Variable stability gives the capability to uncouple them and control each separately. True axis decoupling requires control of all six, but this degree of complexity may not be needed. For example, the NT-33A has control of 3 degrees of freedom (moments only). This capability permits proper angular accelerations, but does not permit an accurate g environment at the cockpit. Direct force control of lift, sideforce, and thrust/drag is necessary to do this. However, adequate results are obtained with this system in the NT-33A because the distance from the pilot to the center of gravity of most fighter aircraft is not grossly different. The long and successful history of the NT-33A demonstrates this. In selecting a base vehicle, it is possible that, say, candidate C may require only 3 degrees of freedom to simulate A, B, D, and E, whereas all others need more than 3 to simulate at least one of the others.

(3) Type of Variable Stability Mechanization

The mechanization scheme may influence the base vehicle selection, and vice versa. As stated earlier, Response Feedback uses known dynamics, whereas model following uses aerodynamic coefficients (of course, once the coefficients are known, the dynamics can be determined).

Since the GTB will be simulating a variety of existing aircraft whose characteristics are known, and since the aircraft will not be a general purpose testbed, the choice between Response Feedback and Model Following may not be a driving factor. Indeed, other factors such as internal volume, power availability, or cost could impact this selection.

c. Follow-On Effort

This discussion on variable stability is included at this point primarily for information and food for thought. The need for and type of variable stability system will have to be addressed and resolved as the GTB development progresses. One question which could be addressed early on is whether flying qualities and handling characteristics affect the pilot's ability to launch missiles from low altitude at high speed with accuracy. If they are not, a variable stability system would not be required.

SECTION VIII

EVAULATION OF ALTERNATIVE CONCEPTS

If the single purpose of the Generic Test Bed is to flight test avionics, anyone of several existing AFSC aircraft resources are capable of meeting this requirement. We even have in existence organizations that can modify, operate, and maintain these aircraft. What is currently lacking within the NA/AW community is a management organization that can prioritize, schedule, test, define test requirements, correlate data, and specifically insure meaningful test results.

If, as we propose, the GTB aircraft is to be used for, not only flight testing prototype and developmental NA/AW avionics, but to assess pilot work load under realistic flight conditions, enhance data derived from ground based simulation and avionic development programs, several alternatives are possible. The following subparagraphs contain a synopsis of the various design alternatives. As previously mentioned the factors used in evaluating the alternative concepts, in order of importance, were:

- Extent of the modification - difficulty and cost
- Validity of data obtainable during flight test
- Flexibility

1. MODULAR PANELS CONCEPT

This concept could be applicable to either corporate jet aircraft or to fighter aircraft and could operate in the dynamic region of the NA/AW environment. This concept offers several attractive features. The modification required to prepare for a plug-in, pull-out type of panel were judged acceptable from a risk and cost viewpoint. The human factors data gathered could be derived from a cockpit that replicates the NA/AW aircraft in question and, therefore, would constitute a reliable baseline. A number of panels could be built independent of the aircraft permitting preparation for the next series of flight tests insuring maximum utilization. If the aircraft was equipped with a 1553B MUX Bus, the potential for quicker turn around times could be realized. There are some drawbacks to this proposal. Dependent on the GTB aircraft selected, a variable stability flight control system may or may not be "easily" added. Further, if the GTB aircraft selected has a side-by-side cockpit, the modifications required to simulate NA/AW aircraft becomes more difficult. Overall, though, this concept was judged acceptable.

2. MODULAR PANELS CONCEPT

Because this concept involved extensive design and structural changes to the GTB aircraft, extensive turnaround times, and major modifications to the flight controls, life support, etc. systems, the concept was disregarded.

3. MULTIPLE AIRCRAFT CONCEPT

This concept offers a number of attractive features. The aircraft could be configured to represent the actual NA/AW aircraft, provide realistic cues to the pilots and would not require extensive modifications. Some drawbacks associated with this concept include very limited capability to investigate new concepts in cockpit designs, require several aircraft to be modified and maintained, and create a fleet of unique aircraft which may or may not be fully utilized.

It was judged that this concept would be better suited for point source design studies. In fact, a number of these aircraft are currently being used by both the 6510th Test Wing at Edwards and the 3246th Test Wing at Eglin. This concept was disregarded as a viable GTB alternative.

4. TCV CONCEPT

This concept requires an aircraft with the capability to have a test cockpit installed internally. This aircraft would likely not be able to perform in the altitude and airspeed environment of a NA/AW aircraft. A large aircraft is more appropriate to the flight testing of breadboard avionics. The 4950th Test Wing at Wright-Patterson AFB is equipped with a number of aircraft for that purpose. Based upon the very extensive modifications necessary for putting in a second flight deck, and the questions concerning validity of the data obtained, the TCV concept was judged unacceptable.

5. TIFS CONCEPT

The disadvantages to this concept are similar to those identified under the TCV concept. The human factors data derived for the NA/AW mission by a large aircraft was judged suspect when applied to a small fighter aircraft with very different dynamics. There was almost total agreement of this by the human factors engineers and management of CALSPAN Corp, AFWAL/TE, NASA Langley, and ASD/ENECH. The cost involved was also prohibitive. The original TIFS was to have several test cockpits, but costs drove the program to one test cockpit and one ferry nose.

6. GENERIC COCKPIT CONCEPT

This concept is similar to the modular panel concept described previously except the generic cockpit aircraft would not be modified to represent particular NA/AW aircraft cockpits. The advantages and disadvantages are similar to the modular panel concept with the added disadvantage of reduced validity of pilot work load data. This is because the aircraft does not duplicate, only represents, various candidate NA/AW aircraft. This concept was judged to be acceptable if a reduction in GTB goals (e.g., loss of valid pilot work load measurements) is permissible.

SECTION IX

SELECTION OF CANDIDATE AIRCRAFT

This vehicle must be able to approach the performance characteristics (low altitude, speed, G loading, turn rates, etc.) of the aircraft the avionics is being designed for but not necessarily exactly replicate the point design aircraft performance. This GTB must be able to investigate the work load for a single pilot and/or a crew of two. In order to monitor the activity of a crew of two, provisions must be available for at least a third party to observe the crew and perhaps alter the brass-board electronic array to modify the test equipment characteristics in flight. The aircraft should have the capability to simulate weapon delivery in order to provide appropriate environmental testing. Sufficient internal volume should be available for analog, ditigal, and video recording instrumentation. The current on-board systems as well as added avionics should lend themselves to being compatable with MIL-STD-1553B. The cockpit of the GTB should be easily modifiable to permit the point design aircraft cockpit design to be installed because it is in this environment in which the new piece of equipment will be flown. It is only in this environment that a Human Factors Engineer can adequately measure the effect on crew performance by the new avionics design. The specific array and combination of controls and displays of equipment drive the crew work load. If an improper test cockpit is used, the result is skewed data which may lead to a poor system design which in turn may lead to costly redesign of the system at the OT&E stage. This is precisely what the GTB is envisioned to preclude.

Twenty-nine aircraft were studied under this phase of the analysis. The aircraft consisted of a mix of fighters, trainers, cargo, and business/executive jets. Several were eliminated from contention immediately because they did not meet the NA/AW dynamic performance requirements, did not have a second seat for use by a safety pilot, or were questionable from an availability standpoint. The factors used in judging the aircraft are as follows:

- Adaptability of the A/C to the modification
- Validity of flight test data collected
- Availability of the aircraft
- Flexibility to meet future requirements
- Operating/maintenance costs/flight hour
- Current on-board systems

1. DISCUSSION

Table 3 contains a matrix of the candidate aircraft which remained after we ran our initial selection review. The matrix presents a synopsis of each aircraft and how it compares with our rating factors. A second selection review was made based on the information obtained while completing Table 3. The following aircraft were identified as best able to meet the requirements of a GTB.

TABLE 3. CANDIDATE AIRCRAFT, SYNOPIS

FACTORS \ AIRCRAFT	A-6E	A-7K	A-10B
ADAPTABILITY TO THE MODIFICATION	Cockpit adaptable to modular panel concept. 60 KVA Power and Cooling systems available	Cockpit adaptable to modular panel concept.	Cockpit adaptable to modular panel concept. 60/80 KVA Power and Cooling available
VALIDITY OF THE DATA COLLECTED	low-level attack bomber all-weather capability flies NA/AW Mission Profiles	low-level light attack aircraft flies NA/AW Mission Profiles	night/adverse weather attack aircraft low-level capability
AVAILABILITY OF A/C TO SUPPORT PROGRAM	Navy resource 600 plus produced	42 are to be built for the US Air National Guard	one-of-a-kind aircraft. Fairchild resource
FLEXIBILITY	good growth potential cockpit can be reconfigured wing stores large payload capacity	good growth potential cockpit can be reconfigured large payload capacity	good growth potential cockpit can be reconfigured large payload capacity
OPERATING AND MAINTENANCE COSTS	$2000/flight hour	A-7: $2268/flight hour	A-10A: $1948/flight hour
CURRENT A/C ON-BOARD CAPABILITY	multi-mode radar TA/TF Digital Computer Radar Altimeter	Navigation /Weapon delivery computer Doppler radar forward looking radar TF	FLIR Radar Altimeter TF/TA radar laser Seeker
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

FACTORS \ AIRCRAFT	A-37	C-9	C-12
ADAPTABILITY TO THE MODIFICATION	Cockpit not easily adaptable to Modular Panel Concept. 2-man side-by-side seating	3 man flight deck. Large cargo Section for instrumentation, cockpit adaptable to Modular Panel Concept Payload 24,749 pounds	2 man side-by-side seating cockpit not easily adaptable to modular panel concept Large section for on-board instrument.
VALIDITY OF THE DATA COLLECTED	instrumented for night missions used for armed counter-insurgency operations	Cannot fly NA/AW Mission Profiles Safety-of-flight restriction preclude low-level missions	Can-not fly NA/AW Mission Profiles
AVAILABILITY OF A/C TO SUPPORT PROGRAM	564 delivered to USAF, and foreign nations	Total USAF buy-21 aircraft Primary mission is air evacuation	30 aircraft delivered to USAF
FLEXIBILITY	limited internal volume available limited electrical power cockpit is not very flexible	Good growth potential cockpit configuration is flexible good candidate for avionics test bed	two 250 VA inverters large cargo area cockpit flexibility is limited two 250 A 28V generators
OPERATING AND MAINTENANCE COSTS	$565/flight hour	$1190/flight hour	$180/flight hour
CURRENT A/C ON-BOARD CAPABILITY	full blind-flying instrumentation counter-insurgency weapon delivery system, wing stores	120 KVA electrical power available Radar Altimeter TACAN UHF/VHF/HF	Standard commercial avionics weather radar
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

AIRCRAFT / FACTORS	C-130E	C-131E	C-140
ADAPTABILITY TO THE MODIFICATION	4 man flight deck large cargo section for flight test instrumentation-large payload. **Cockpit** can be modified for panel concept.	2 man flight deck large cargo section for flight test instrumentation - Payload of 9540 lbs. cockpit can be adapted to modular panel concept	2-3 man flight deck payload of 16770 lbs permits adequate flight test instr. package. Cockpit adequate for modular panel installation.
[illegible] OF THE DATA [illegible]	MC-130E's do fly low level missions at night with special avionics. Performance not that of a fighter. Safety of crew ~~concerns.~~	cannot fly NA/AW mission profiles	0.53 mach at **S.L.** rate of climb at S.L. 4,200 fpm can be adapted to fly NA/AW mission profiles
AVAILABILITY OF A/C TO SUPPORT PROGRAM	mainstay of USAF's intertheater transport capability. 503 produced. AFSC utilizes several as flight test vehicles.	All C-131's are now in storage AFSC had several configures specifically for flight test.	15 Jetstar IIs delivered to USAF. AFCS and 84 MAW resources. Light utility transport.
[illegible]IBILITY	large growth potential 4 40 KVA generators plus APU extremely flexible aircraft	good growth potential cockpit not easily altered to new configurations	cockpit acceptable good growth potential for instrumentation. minimal electrical power available
[illegible] AND MAINTENANCE COSTS	$2070/flight hour	$459/flight hour	not available
[illegible] ON-BOARD CAPABILITY	MC-130E's have special avionics for covering infiltration missions. APN - 59B radar APN-147 Doppler Nav.	E-4 Auto pilot MA-1 Flight Director	ARC-21 TACAM Doppler Nav. and computer weather radar can be used for TA and mapping.
[illegible]	YES	YES	YES

TABLE 3. CONTINUED

FACTORS \ AIRCRAFT	CESSNA CITATION I/II	DIAMOND I	LEARJET SERIES 35A / 36A
ADAPTABILITY TO THE MODIFICATION	2 man cockpit, not readily adaptable to modular panel concept. Payload-1000 pounds/2000 pounds	2 man cockpit not readily adaptable to modular panel concept. payload - 1900 pounds	2 man cockpit with limited capability to modify payload - 2000 pounds/4000 lbs
VALIDITY OF THE DATA COLLECTED	0.7 mach maximum cruise. No S.L. capability. cannot fly NA/AW mission profiles	maximum cruise is 0.51 mach at 16000 feet. No S.L. capability cannot fly NA/AW mission profiles executive transport.	maximum cruise - 450 knots at FL470 No S.L. capability. Cannot fly NA/AW mission profiles.
AVAILABILITY OF A/C TO SUPPORT PROGRAM	350 produced executive transport US customs service has one	Currently in production. 40 planned deliveries in 1981	1000 produced. Sea patrol version prototyped
FLEXIBILITY	good growth potential in passenger section and baggage areas. cockpit small minimal electrical power available.	good growth potential in passenger section and baggage area. Minimal electrical power available	good growth potential in passenger section and baggage areas minimal electrical power available
OPERATING AND MAINTENANCE COSTS	Approximately $200/flight hour (1978)	$411/flight hours	approximately $350/flight hour (1979)
CURRENT A/C ON-BOARD CAPABILITY	Standard commercial category II avionics package	Standard avionics includes ranging radar, HUD and SIF/IFF	Standard avionics Military avionics available in sea patrol prototype
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

FACTORS \ AIRCRAFT	F-4E/RF-4C	F-5	F-14
ADAPTABILITY TO THE MODIFICATION	2 man tandem cockpit adaptable to the Modular Panel Concept. Aircraft has been a real work horse in the arena of flight test	F-5F 2 man tandem cockpit small but adaptable to Modular Panel Concept. Small payload/space available. Two 13/15 KVA alternaters provide electrical power. Cooling to avionics also available.	2 man tandem cockpit adaptable to the Modular Panel Concept. Adequate Power and Cooling capacities available
VALIDITY OF THE DATA COLLECTED	Multi-role fighter for air superiority, close support and interdiction missions. Can fly NA/AW Mission Profiles	Multi-role international fighter. Can fly NA/AW Mission Profiles	Multi-role fighter for air superiority, CAP and ground attack Can fly NA/AW Mission Profiles
AVAILABILITY OF A/C TO SUPPORT PROGRAM	Over 5000 produced. Many are assigned to AFSC	*Primarily for foreign sales.* USAF has F-5E single seat aircraft only.	390 planned production first line Navy weapon System
FLEXIBILITY	Excellent growth potential Has been reliable flight test vehicle Cockpit adaptable to new Config.	Not an excessive amount of growth potential. Cockpit is adaptable to advanced designs	Good growth potential Cockpit adaptable to advanced designs
OPERATING AND MAINTENANCE COSTS	F-4E $3867/flight hour RF-4C $3720/flight hour	Not Available	$4100/flight hour
CURRENT A/C ON-BOARD CAPABILITY	APN-155 radar altimeter ASN-63 INS ASA-32 AFCS	ARN-84 TACAN APQ-157 Fire control radar LN -33 INS optional Full blind flying instrumentation	AFCS Radar Altimeter INS
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

FACTORS \ AIRCRAFT	F-15B	F-16B	F-111D/F
ADAPTABILITY TO THE MODIFICATION	Cockpit adaptable to Modular Panel Concept 40/50 KVA Power available with adequate cooling	Cockpit adaptable to modular panel concept. 40 KVA electrical and cooling systems available.	Cockpit adaptable to modular Panel Concepts. Adequate electrical and cooling systems available
VALIDITY OF THE DATA COLLECTED	air-to-ground attack role is secondary mission of aircraft. Can fly NA/AW Mission Profiles	Air-to-ground mission basic to F-16 cockpit configured for high g tolerance can fly NA/AW Mission Profiles	All-weather day and night interdiction aircraft minimum terrain clearance capability.
AVAILABILITY OF A/C TO SUPPORT PROGRAM	Primary USAF air superiority aircraft. AFSC has some in its command inventory	limited procurement. 204 planned to buy. Some in AFSC inventory. First line fighter for USAF	Several in AFSC inventory 96 F-111 Ds 106 F-111 Fs First line fighter for USAF
FLEXIBILITY	Aircraft has adequate growth potential. Cockpit large and adaptable to advanced Panel Concepts.	Cockpit configuration unique. Not easily adaptable to advanced panel concepts. Wing stores, large payload capacity	limited growth or design option capabilities associated with crew capsule. large Payload Capacity
OPERATING AND MAINTENANCE COSTS	$4114/flight hour	$2218/flight hour	F-111 D: $5119/flight hour F-111 F: $4004/flight hour
CURRENT A/C ON-BOARD CAPABILITY	APG-63 Doppler radar penetration aids	Pulse - Doppler radar INS HUD	Radar Altimeter TF/TA Penetration Aids
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

AIRFRAME / FACTORS	FALCON SERIES 10 and 20	GULFSTREAM II/III	JETSTAR II
ADAPTABILITY TO THE MODIFICATION	2 man cockpit payload capability-2600 pounds cockpit adequate for modular panel installation	2 man cockpit with limited capability to modify. large passenger section payload-2000 lbs/4500 lbs	See C-140 for applicable Jetstar II information
VALIDITY OF THE DATA COLLECTED	0.53 mach at S.L. (350 knots) can be adapted to fly NA/AW mission profiles. Some used to train Mirage pilots	No S.L. capability, 505 knots at FL250 executive transports cannot fly NA/AW mission profiles	
AVAILABILITY OF A/C TO SUPPORT PROGRAM	459 produced *USCG planning to procure 41 HU-25A Guardians.	256 II's produced 43 III's produced 3 maritime surveillance versions, VC-11A	apparently only 40 have been produced.
FLEXIBILITY	Hard points on HU-25A good growth potential in cabin and baggage area. minimal electrical power available.	good growth potential in passenger section and baggage areas. cockpit limited 2 20 KVA alternators for electrical power.	
OPERATING AND MAINTENANCE COSTS	not available	$4000/flight hour	
CURRENT A/C ON-BOARD CAPABILITY	Standard commercial avionics USCG version includes FLIR and laser illuminated TV	standard commercial avionics	
[illegible]	YES	YES	

TABLE 3. CONTINUED

FACTORS / AIRCRAFT	S-3A	T-37	T-38
ADAPTABILITY TO THE MODIFICATION	Multi-role 4 place ASW aircraft Pilot/copilot sit side by side, sensor operators behind. Modular Panel Concept feasible. Two 75 KVA generators provide electrical power.	2 man side-by-side cockpit Cockpit probably adaptable to the Modular Panel Concept Small Payload capability	2 man tandem cockpit adaptable to Modular Panel Concept Small Payload capability
VALIDITY OF THE DATA COLLECTED	Multi-role aircraft can fly NA/AW Mission Profiles	Basic trainer for USAF Could fly NA/AW Mission Profiles	USAF Supersonic flight trainer can fly NA/AW Mission Profiles
AVAILABILITY OF A/C TO SUPPORT PROGRAM	187 produced for Navy Several non-carrier qualified A/C available	USAF Basic Trainer AFSC operates several flight test configured vehicles	Currently in ATC and AFSC inventories
FLEXIBILITY	Fuselage volume allows for 50% growth in avionics. Extremely flexible aircraft Ideally suited for GTB	T-37C has wing hard points small growth allowance cockpit small with minimal ability to adapt to new advanced designs	Cockpit small Small growth allowance
OPERATING AND MAINTENANCE COSTS	$1300/Flight hour	$310/Flight hour	$707/Flight hour
CURRENT A/C ON-BOARD CAPABILITY	APS-116 radar OR -89/AA FLIR ASN-92(V) INS APN-200 Doppler APN-201 radar altimeter	Navigation equipment, instrumentation for day and night operations	ARN-118 TACAN can fly night and in moderately adverse weather with existing avionics
SAFETY PILOT	YES	YES	YES

TABLE 3. CONTINUED

FACTORS \ AIRCRAFT	T-39		
ADAPTABILITY TO THE MODIFICATION	2 man flight deck not readily adaptable to modular design concept. Payload-1460 pounds		
VALIDITY OF THE DATA COLLECTED	350 knots at S.L. used for pilot proficiency and as executive transport. Can be adapted to fly NA/AW mission profiles.		
AVAILABILITY OF A/C TO SUPPORT PROGRAM	143 delivered. Currently in AFSC and MAC inventories.		
FLEXIBILITY	medium growth potential in passenger section minimal electrical power available.		
OPERATING AND MAINTENANCE COSTS	$599/flight hour		
CURRENT A/C ON-BOARD CAPABILITY	ARN-21C TACAN APN-59 RDF APX-46V IFF/SIF		
SAFETY PILOT	YES		

a. A-6E

Known as a carrier-borne low-level attack bomber equipped specifically to deliver nuclear or conventional weapons on targets obscurred by weather or darkness. The aircraft is powered by two Pratt and Whitney J52-P-8A turbo jet engines. The crew use Martin-Baker MK-GRU7 ejection seats which can be reclined to reduce fatigue during low-level operations. Electrical power is provided by two 30KVA generators. Maximum level speed and rate of climb at sea level are 562 knots and 9,400 fpm respectively. The following is a list of some on-board avionics:

- APQ-148 multi-mode radar - Provides simultaneous ground mapping, terrain-clearance, or terrain following maneuvers.

- ASQ-133 digital computer - Coupled to the radar, inertial and doppler navigation equipment, comm., and AFCS.

- AVA-1 Multi-mode display - Developed by Kaiser, serves as a primary flight aid for navigation (TA-TF), approach, landing, and weapon delivery.

- radar altimeter

b. A-7K

Basically a light attack/close air support/interdiction aircraft. The aircraft is powered by a TF41-A-2 non-afterburning turbofan engine. The crew, in a tandem cockpit, use Escapac ejection seats. Electrical system includes storage batteries for engine starting and maintenance of ground alert radio communications. Maximum low level speed and rate of climb at sea level are 530 knots and 7,900 fpm respectively. The following is a list of some on-board avionics (available in the YA-7 configuration):

- FLIR

- APQ-126 forward looking radar

- automatic or manual terrain following

- ground mapping system

- APN-141 radar altimeter

- APN-190 doppler radar

- ASN-91 automatic navigation and weapons delivery computer

- ASN-99 automatic projected map display system

c. A-10B

Two-seat version of the A-10A is intended as a night/adverse weather attack aircraft. The second cockpit duplicates that of the pilot except that a CRT is used in lieu of a HUD. Both ejection seats are ACES II. Electrical power is provided by two 30/40 KVA generators. Cruising speed and maximum rate of climb at sea level are 300 knots and 6,000 fpm respectively. Some of the current on-board systems are listed below:

- FLIR

- Modified WX-50 multimode radar - Used as ground moving target indicator, for ground mapping, TF/TA, and threat detection

- laser range finder

- LN-39 INS

- radar altimeter

- low light level TV (included for comparison with FLIR)

- Pave Penny laser target designator

d. F-4E

Basically a multi-role fighter for air superiority/close air support/ interdiction missions. The crew, in a tandem cockpit, use Martin-Baker MK47 ejection seats. The aircraft is powered by two J79-GE-17A turbojet engines. This all-weather fighter has a low level speed and rate of climb at sea level of 550 knots and 6,170 fpm respectively. Some of the on-board avionics are listed below:

- APN-155 radar altimeter

- ASN-63 INS

- APR-36, -37 RHAWS

- ASA-32 AFCS

- APQ-120 fire control system radar

e. F-14

This aircraft is designed to fullfil three primary missions; fighter sweep/escort, combat air patrol and deck launched intercept and finally secondary attack of tactical ground targets. The two-man crew ride on

Martin-Baker GRU-7A ejection seats. The F-14 has a low level speed and rate of climb at sea level of 607 knots and 9,600 fpm respectively. The following is a list of some on-board avionics:

- AWG-9 weapon control system
- AVG-12 vertical and HUD system
- ASW-43A AFCS
- APN-194 radar altimeter
- ASN-92 INS

f. F-15B

Designed specifically as an air superiority aircraft, the F-15 has proved equally suitable for air-to-ground missions. The crew uses ACES II ejection seats. Electrical power is provided by a 40/50 KVA generator. The following is a list of some on-board avionics:

- APG-63 pulse-doppler radar
- vertical situation display
- INS
- penetration aids (TEWS) system

g. F-16B

Originally acquired for an air superiority day fighter, the F-16's role was expanded to give equal emphasis to air-to-ground missions. Crew uses ACES II ejection seats with the seats inclined 30 aft to improve crew tolerance to high G forces. Electrical power is provided by engine-driven 40 KVA generators. Four dedicated batteries provide transient electrical power protection for the fly-by-wire flight control system. Some of the on-board avionics are listed below:

- pulse-doppler range and angle track radar
- inertial navigation system
- ARN-108 ILS
- HUD
- HSI

h. S-3A

The S-3A is a carrier-borne anti-submarine aircraft. The performance characteristics make it possible to modify its mission as required. For example, the S-3A can be a tanker, ASW command and control, and a variety of electronic countermeasures aircraft. The fuselage volume allows for 50 percent expansion of electronics equipment. The aircraft is powered by two TF34-GE-2 high bypass ratio turbofan engines. The pilot and co-pilot are side-by-side on the flight deck with two sensor operators accommodated in an aft cabin. All use Escapac 1-E Zero-Zero ejection seats. Electrical system includes two 75 KVA generators. Two transformer-rectifiers deliver 28 VDC at 200 A. An APU provides 5 KVA for emergency electrical power. The S-3A has a level speed and rate of climb at sea level of 429 knots and 4,500 fpm respectively. Some of the on-board avionics are:

- ASN-92 INS
- ASN-107 AHRS
- APN-200 doppler ground velocity
- APN-201 radar altimeter
- ASW-33 AFCS
- AYK-10 digital computer

2. ORDER OF PREFERENCE - CANDIDATE AIRCRAFT

The aircraft which we consider to be the best candidates for the role of a GTB are listed below in a descending order of preference:

a. S-3A

b. A-6E, F-4E, F-14, F-15B, RF-4C

c. F-16B

d. A-7K

e. A-10B

The order of preference for selecting the best candidates was derived from an analysis of the data contained in Table 3 and Section IX, Paragraph 1. The S-3A is our first choice. Section XI, Paragraph 2, will expand on the reasons why this aircraft is preferred. The A-6E, F-4E/RF-4C, F-14, and F-15B were judged equally acceptable. The F-16B was selected third primarily because of its unique cockpit configuration which made it more difficult to employ the modular panel concept. The tilt back seat, side stick controller and fly-by-wire flight control system make for a very unique aircraft. The A-7K was preferred next because of its limited availability. The same reason applied to the one-of-a-kind A-10B.

SECTION X

MANAGEMENT ORGANIZATION

In establishing a structure for the GTB project, management factors must be considered. Effective management can lead to program efficiency and, in the case of the GTB project, a well structured investigative process. In establishing a management structure, several key factors need to be considered. Areas of responsibility and interaction need to be defined clearly, adequate mechanisms for controllability have to be established, and a credible base of corporate memory and expertise must be established. Some to the following are specific responsibilities the GTB mangement organization will have:

a. Ensures data is in a useable form to the NA/AW mission community and that a well structured historical data base is maintained.

b. Ensures full utilization of the GTB resources.

c. Establishes an operation and maintenance capability.

d. Develops a flight test instrumentation package, telemetry and data reduction capability.

1. MODIFICATION OF THE GTB

The modifications required to the GTB in order to support all the various testing required of it could be accomplished either in-house by the 4950th Test Wing or by one of several airframe manufacturers or contractor flight test organizations. The initial modifications required to turn the aircraft into a GTB may be too extensive to have accomplished in-house and may have to be contracted out. According to existing Air Force Regulations, a Program Introduction Document (PID) would have to be prepared and submitted to the 4950th Test Wing prior to any decision to go on the street with an RFP. It would then be up to the test wing to make a determination as to whether the job could be done in-house.

2. OPERATION AND MAINTENANCE OF THE GTB

The Air Force has several organizations who can operate and maintain specialized flight test vehicles. All three AFSC flight test centers would have the capability to operate and maintain the GTB. Depot maintenance would be performed by that aircraft's particular depot whether Air Force or Navy. Another alternative which has proven successful requires the service of a contractor who operates and maintains the aircraft.

3. LOCATION OF THE MANAGEMENT ORGANIZATION

We believe the GTB project should be managed from Wright-Patterson AFB because the Aeronautical Systems Division is heavily involved in the development of NA/AW mission avionics and because of our technical expertise with flight testing.

There are three organizations at ASD who could possibly manage the GTB project. A Systems Program Office could be formed, the Deputy for Engineering could establish a unique division or office, or the Air Force Wright Aeronautical Laboratories could be used.

SECTION XI

RECOMMENDATIONS

As avionics systems advance from breadboard through development and into production, there is a requirement for evaluation at each stage to determine whether the system should advance to the next stage or go back to a previous stage to correct a deficiency which may have shown up as a result of the evaluation process. The further a system proceeds, the more costly it is to send it back to reaccomplish a previous stage, both in dollars and time. The availability of a flexible evaluation tool, properly managed, which could be used for simple compatibility testing to full operational suitability testing would greatly enhance the NA/AW avionics acquisition process.

The Generic Test Bed would satisfy our needs for this flexible evaluation tool. It is apparent from preceding discussions that there are potential areas where benefits can be achieved through use of the GTB concept. These areas are summarized below:

- Lower modification/demodification costs
- Increased test aircraft availability
- Savings due to simultaneous project activities
- Efficiency due to continuity of flight test function
- Effectiveness due to testing avionics system interoperability
- Benefits of earlier data for decision making process
- Provides an integrated management program

1. DESIGN ALTERNATIVES

We believe the GTB project should embrace the total concept of an avionics test bed with the capability to analyze pilot work load levels. The only viable design alternative which gives us this capability is the "modular panels." This design alternative has many favorable features which make it extremely attractive. The side consoles and forward instrument panel would be designed as pull-out/plug-in modules. Throttle and stick controllers would also be modified to simulate particular NA/AW candidate aircraft (e.g., side stick of F-16 versus center pole of F-15). The modules give us the capability to simulate as much as possible existing aircraft, as well as future or advanced cockpit designs with minimal modification turnaround times. This feature permits maximum utilization of GTB resources. Credible flight test data will be obtained not only on the avionics under test but also on the impact this avionics has on pilot work load. This is because the GTB would have the capability for realistic testing in an actual environment.

The decision to install a variable stability flight control system on the GTB cannot be made at this time. Due to the high installation costs involved and definite schedule impacts which can be expected, we must determine just how critical it is to duplicate actual aircraft flight characteristics and the rate of return we can expect on our dollar investment versus the expected delta increase in validated flight test data.

2. CANDIDATE AIRCRAFT

When we consider operations scheduling and support factors such as maintenance, downtime for modifications, and the sometimes extensive number of flight test hours necessary to test a single project, the employment of a single aircraft for the GTB program is highly inefficient and ineffective. A single aircraft is very vulnerable to any of the above mentioned program disruptions. It would be desirable to employ a fleet of at least three GTBs.

The employment of three GTBs would enhance scheduling and provide protection against program disruptions. Three aircraft would permit joint testing between similar systems, interoperability testing between different systems, fly-offs, or permit one aircraft down for maintenance while a second is used to continue testing. The most important feature associated with having three GTBs is that while one may be dedicated to flying one particular avionics suite configured to represent an F-15, a second would still be available for flight testing of other components or systems while the third could support general avionics flight testing.

As noted in the foregoing discussion, the primary aircraft for the GTB role should be the Navy S-3A Viking. The S-3A is a four place, twin turbofan aircraft designed by Lockheed for carrier based anti-submarine warfare operations. It carries surface and subsurface search equipment with integrated target acquisition and sensor coordinating systems which can collect, process, interpret, and store ASW sensor data. It has a direct attack capability with a variety of armament. Additional features include:

- Inertial Navigation System
- General Purpose Digital Computer
- Acoustic Data Processing System
- Air Refueling Capability
- Sequential Crew Ejection
- Auxiliary Power Unit

Two General Electric TF-34-400A high-bypass turbofan engines are installed on pylons mounted under the wing, inboard of the wingfold stations. The TF-34-400A is no longer in production, but the TF-34-100, which is used to power the Air Force's A-10, is very similar. Since

both engines used the same production line, the Navy, if the need arose for additional -400 engines, could have General Electric send them down the current -100 production line. The differences between the engines are basically the following. The -400 has top mounts whereas the -100 has side mounts. This changed the locations of several access/service panels and the location of frequent service parts (although parts are generally the same). The combuster/nozzle assembly is different. The gear box is slightly different. The -100 oil is gravity feed whereas the -400 oil is pressure feed. The -400 has anti-ice, two versus one hydraulic pumps, and a fuel control which compensates for altitude.

The S-3A is an attractive candidate for the role of a Generic Test Bed for several reasons. They are:

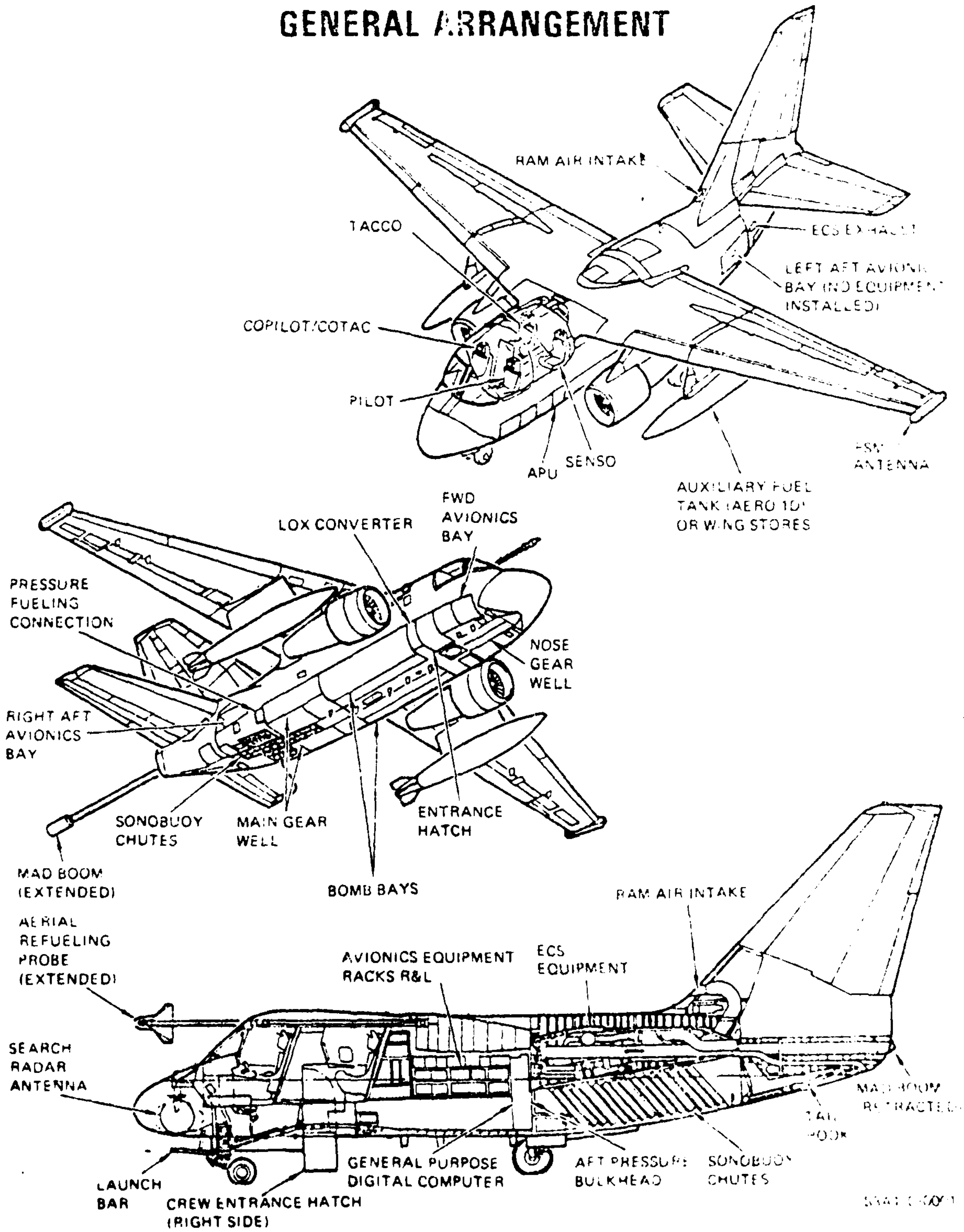
- can fly the NA/AW mission profiles
- has a large avionics bay with extensive growth potential
- adequate cooling and electrical power are available
- weapon delivery capability
- cockpit configuration adaptable to modular panel design alternative
- addition of a variable stability flight control system is feasible
- could be used in joint USAF/Navy tests if necessary
- can fill the role of a medium sized general avionics test bed

One of the biggest advantages to selecting this aircraft is the four crew positions which permit an unlimited range of crew configuration possibilities. One seat would be for the safety pilot, the right seat could be configured with the modular panels for a test pilot, while the remaining two positions could be taken up by a flight test engineer and another test station. Several independent programs could be flight tested concurrently. A dual seat configuration could be designed while still retaining the safety pilot. The four crew positions with crew ejection provides the GTB with a unique low level test capability which is actually unmatched by any other aircraft we could identify. (Figure 5)

The one drawback with selecting an S-3A is that it is a Navy resource. Therefore, availability to the Air Force is an unknown and something which must be resolved. Several S-3As have been identified as being in storage at Davis-Monthem AFB. Whether the Navy is willing to release two or three of these aircraft is the question. We believe the capability of this aircraft to be so unique that the Navy could share in its benefits through joint service testing. Similar to the joint effort currently underway with the NT-33A.

3. MANAGEMENT ORGANIZATION

We believe the Air Force Wright Aeronautical Laboratories is the logical organization to manage the GTB/integrated NA/AW avionics development program. They currently have a well established and functioning organization which specializes in flight testing. They have the program


GENERAL ARRANGEMENT
RAM AIR INTAKE
TACCO
COPILOT/COTAC
PILOT
APU
SENSO
AUXILIARY FUEL
TANK (AERO 1D)
OR WING STORES
FWD
AVIONICS
BAY
LOX CONVERTER
PRESSURE
FUELING
CONNECTION
NOSE
GEAR
WELL
RIGHT AFT
AVIONICS
BAY
SONOBUOY
CHUTES
MAIN GEAR
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BOMB BAYS
RAM AIR INTAKE
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AVIONICS EQUIPMENT
RACKS R&L
ECS
EQUIPMENT
SEARCH
RADAR
ANTENNA
LAUNCH
BAR
CREW ENTRANCE HATCH
(RIGHT SIDE)
GENERAL PURPOSE
DIGITAL COMPUTER
AFT PRESSURE
BULKHEAD
SONOBUOY
CHUTES

FIGURE 5. S-3A

stability needed for long-term research and the capability to develop and maintain an historical data base on NA/AW avionics developments. The Laboratories have the expertise to take the GTB concept, develop it, realize it, and use it in a most cost effective and productive manner to serve all organizations interested in NA/AW avionics development.

We further recommend the 4950th Test Wing be designated as Responsible Test Organization (RTO) for developmental test and evaluation (DT&E). That includes breadboard and prototype phases of avionics hardware development.

The Test Wing can meet the responsibilities of being RTO for the GTB program because they have a complete in-house capability to operate, maintain, modify, and accomplish flight test engineering evaluations. Their resources include: test pilots, flight test engineers, instrumentation engineers, data analysts, modification design engineers and workers, and maintenance specialists. Their experience and these capabilities qualify them now as the prime USAF agency to accomplish avionics DT&E.

The Wing also supports AFWAL regularly and an aircraft such as the S-3A could be used very effectively to support other lab avionics development programs in addition to the NA/AW GTB configuration. The S-3A is the intermediate-sized aircraft that the Wing has been looking for but has been unable to obtain. The payload and attractive operating cost (approximately $1300/flight hour) make it ideal for the tests that are too big for T-39s but not large enough to warrant a C-130, C-135, or C-141. Having an S-3A available to the Wing would give them a more appropriately sized aircraft and would ease the weight and power constraints they now face in trying to develop a Wing EC/COMM/NAV Standard Avionics Test Bed (SATB).

As regards the ground simulator and hot bench mockup, ASD has an ideal facility located at Wright-Patterson AFB which could fulfill this role. The Crew Station Design Facility has the experience, manpower, and capabilities to operate, maintain, modify, and accomplish ground simulations. The Design Facility would need to acquire or build an S-3A crew station. This would enhance their existing inventory of A-10, F-111, and KC-135 cockpits.

4. FOLLOW-ON TASKS

We recommend the Night Attack Workload Steering Group endorse the Generic Test Bed concept. For this concept to become a reality, several important steps must be taken:

a. AFSC, ASD, and AFWAL need to endorse and establish the management concept identified in this report.

b. AFSC needs to establish schedule and funding constraints. Not only will this demonstrate the amount of support for the GTB concept, but constraints in funding and scheduling impact aircraft availability, selection, and on-board flight test capabilities.

c. AFSC should initiate procedures to obtain two S-3A Vikings.

d. AFWAL, in cooperation with the operational Experience and Flight Test Subgroup of the NAWSG, needs to prepare a Program Introduction Document (PID) and/or a Request For Proposal (RFP) for the design and development of two GTB aircraft.

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